The Physical Effects of Polyacrylamide on Natural Resources

by Larry J. Dawson, Thomas L. Spofford and Kendall L. Pfeiffer

The physical effect polyacrylamide (PAM) has on irrigation induced erosion is very graphic and intuitively a good effect. Less dramatically, polyacrylamide also effects many aspects of the soil, water, air, plant and animal resources. Many, but not all effects are desirable.

Through awareness and management, the desirable effects of PAM on various resources can be accented and the undesirable effects minimized. Awareness can be enhanced in the less intuitive areas by considering how PAM effects various resource concerns. To evaluate these effects, the United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS, formally the Soil Conservation Service) developed a Conservation Practice Physical Effects (CPPE) matrix. Use of the CPPE allows for development of a general perspective of the positive or negative effects of various practice applications on various resources.

For a total assessment of polyacrylamide effects, an evaluation must be performed on the specific site. This is needed to address local concerns. Local concerns and subjective, positive or negative, ratings vary with soil characteristics, cultural influences, cultivation practices, as well the management level of irrigation system operation.

The benefit or detriment, associated with polyacrylamide application for the treatment of surface irrigation erosion and sediment yield, can be evaluated. This paper presents a tested, intuitive process for making an assessment of polyacylamide use.

Conservation Practice Physical Effect (CPPE) matrix

During the late 1980s, the USDA-NRCS assessed the basic Soil, Water, Air, Plant, Animal, plus Human (SWAPA+H) resources and associated desired quality of life. The result of this assessment was a process that evolved into a method of evaluating impacts of conservation practice application on the resources. It was concluded that practice application has a direct impact on the H , or Human resource.

To complete the assessment, each of the five primary resources: Soil, Water, Air, Plant, Animal (SWAPA) were evaluated in depth. An assumption was made that whatever occurred on or impacted one of the SWAPA resources, impacts the H or human element. To rate or evaluate this impact, the NRCS developed a Conservation Practice Physical Effects (CPPE) matrix. The development process identified the following primary CPPE concerns, for the five SWAPA resource areas:

▼ Soil

Erosion — Wind or water loss or displacement. This includes soil surface or mass displacement from, natural precipitation, flood, irrigation or construction influence.

Condition — Soil tilth, compaction, contamination or deposition. This includes depletion or build up of organic matter, reduced rooting penetration or water infiltration, nutrient or chemical contamination, and on or off-site damages.

▼ Water

Quantity — Seeps, runoff/flooding, subsurface waters, drainage outlets, irrigation waters, dryland/natural moisture and water conveyances (on and off-site). These include the ability or the land to utilize as well as beneficially transport water volumes.

Quality (Ground Waters) — Pesticides, nutrients (commercial or organic), salinity, heavy metals, and Pathogens. These include items that influence the quality of ground or

subsurface waters or users of the supply.

Quality (Surface Waters) — Pesticides, nutrients (commercial or organic), salinity, suspended sediments and turbidity, dissolved oxygen, temperature, pathogens and aquatic suitability. These include items that influence the quality of surface waters or users of the waters.

▼ Air

Quality — Soil particles, smoke, chemicals, odors, condition (temperature, humidity, velocity, etc.). This technology is still developing Items that impact off and on-site health, safety, and property are addressed. Also, conditions that impact visibility and flora or fauna development are addressed.

▼ Plants

Suitability, Condition and Management — The existence of native vegetation or the ability of plants to adapt and produce, as well as the ability of plant communities to control or reduce undesirable species. This applies to native, introduced or agricultural sites.

▼ Animals

Domestic or wildlife elements of habitat, cover and/or shelter, water and related management —This encompasses adequate food and or water supply, appropriate shade/cover, population and health balance as well as the production or sustainable goals desired.

Upon completion of assessment, 73 individual resource concerns were identified. These 73 concerns resulted in the CPPE matrix. Analysis concluded that several, but not all, of these 73 concerns could occur any time on a given resource. Exhibit 1 presents an example of CPPE application in the evaluation of polyacrylamide used for furrow irrigation sediment treatment.

Use and application of the CPPE resource evaluation process is qualitative and judgmental. NRCS use of the matrix notes that various individuals will rate differently but the overall assessment of a treatment being positive or negative generally comes out the same. In Exhibit 1, it is easily noted that sediment reduction has positive impacts on numerous resources. The weakness of the practice shows up in the irrigation benefit of better infiltration, which may have negative impact on other resources.

Use and interpretation of the rating would indicate to a planner that the use of polyacylamide in furrow irrigation systems would require a companion practice to minimize deep percolation problems. Exhibit 1 readily indicates that when PAM is used, irrigation water management practices need to be adjusted. Knowledge of this problem and adjustment of stream sizes or irrigation set times would turn many of the negative effects into positive ones. Remaining negative effects can be offset by applying other conservation practices.

Summary

The CPPE matrix provides a tool and means for a qualitative process to evaluate the potential resource impacts of various treatments or practice applications. While benefits may be visualized for a select situation, the matrix allows for a broader assessment of total resource implications.

Like any new technology, polyacylamide use in irrigation systems will require knowledgeable and enhanced management to fully benefit Soil, Water, Animal, Plant and Air, plus Human resources. CPPE evaluation indicates that polyacrylamide applications, with modified irrigation water management practices, will provide an overall SWAPA+H resource benefit.

About the authors

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EXHIBIT 1 RESOURCE CONCERNS FROM THE CPPE MATRIX

NRCS rating in the use of the CPPE matrix generally rates elements as: N/A — Not applicable; + — An application that provides a positive improvement upon resource conditions or the reduction of risk to the resource; - —An application that degrades resource conditions or increases the risk of damage to resources; and 0 — An application that provides negligible effect.

The process was modified for this presentation to: +++ — Provides a significant benefit to the resource; ++ — Provides a known benefit to the resource; + — Some benefit to the resource; ? — Either a positive or negative benefit exists but information is being researched or does not exist; - — Some detriment to the resource may be present; -- — Negative impacts may result --- — A total detriment to the environment

Resource Setting Evaluated:

An intensive irrigated crop and livestock producing area. Off-site, downstream areas watershed elements include spawning streams and a wildlife preserve. In the matrix rating, rationale for the rating is presented in normal type.

Matrix Rating

SOIL EROSION	
sheet and rill residual	
PAM reduces precipitation erosion in irrigated field	+
wind	
residual PAM holds soil particles together in irrigated fields	+
ephemeral gully/concentrated flow	
infield infiltration increase and	+
less volume of water available for flow	+
classic gully	?
streambank	
residual PAM in the runoff will help stabilize banks	+
irrigation induced	
significant reduction in erosion through particle bonding and flocculation occurring	+++
soil mass movement	NA
road banks and construction sites	NA
SOIL CONDITION	
soil tilth	
bonds particles and maintains top soil in place	+++
soil crusting can be accelerated or worsened	--
soil compaction	
decreased field traffic to reopen furrows	+
increased fall moisture increases fall compaction	-
excess chemical contaminants	
increased infiltration increases leaching potential	--
excess animal waste	
increased infiltration increases leaching potential	--
excess fertilizer	
increased infiltration increases leaching potential	--
excess pesticides	
increased infiltration increases leaching potential	--
SOIL DEPOSITION	
damage on-site	
erosion significantly reduced materials for deposition diminished	+++
damage off-site	
erosion significantly reduced materials for deposition diminished	+++
safety on-site	
erosion and roughness reduced	++
safety off-site	?

WATER QUANTITY	
seeps	
increased infiltration impacts on adjoining saline seep	–
runoff/flooding	
improves infiltration on irrigated lands and reduces runoff volumes from natural precipitation.	+
excess surface water	
improved infiltration on irrigated lands and reduces runoff volumes from natural precipitation.	+
inadequate outlets	NA
water management for irrigated land	
improves infiltration where low soil intake is a problem	++
helps increase the furrow advance rates on high infiltration soils	++
water management for non-irrigated land	NA
restricted capacity from sediment on-site	
erosion on-site diminished and sediment significantly reduced.	+++
restricted capacity from sediment off-site	
erosion on-site diminished and sediment volumes significantly reduced.	++
restricted capacity of water bodies	
erosion on-site diminished and sediment volumes significantly reduced.	++
GROUND WATER CONTAMINATES	
pesticides	
increased with infiltration improvements resulting in additional deep percolation	--
nutrients and organics	
increased with infiltration improvements resulting in additional deep percolation	--
salt	
increased with infiltration improvements resulting in additional deep percolation	–
heavy metals	
increased with infiltration improvements resulting in additional deep percolation however most metals don t leach	?
pathogens	
increased with infiltration improvements resulting in additional deep percolation	--
SURFACE WATER CONTAMINATES	
pesticides	
less runoff for soluble transport	+
less sediment for attachment transport	+++
nutrients and organics	
less runoff for soluble transport	+
less sediment for attachment transport	+++
suspended sediment and turbidity	
less sediment transport	+++
low dissolved oxygen	
less sediment transport	++
salt	
less runoff for soluble transport	+
less sediment for attachment transport	+++
heavy metals	
less runoff for soluble transport	+
less sediment for attachment transport	+++
temperature	?
pathogens	
less runoff for soluble transport	+
aquatic habitat suitability	
erosion and sediment yield reduced	++

AIR QUALITY	
airborne sediment and smoke safety on-site	?
airborne sediment and smoke safety off-site	?
airborne sediment causing problems on-site	?
airborne sediment causing problems off-site	?
airborne sediment & smoke causing health problems on-site	?
airborne sediment & smoke causing health problems off-site	?
airborne sediment causing conveyance problems	?
airborne chemical drift	?
airborne odors	NA
AIR CONDITION	
air temperature	NA
air movement	NA
humidity	?
PLANT SUITABILITY	
plants are not well adapted to site	NA
plants are unsuitable for intended use	NA
PLANT CONDITION	
productivity	
plant population is better in lower 1/3 of field from improved application and infiltration	++
health and vigor	
plant population is better in lower 1/3 of field from improved application and infiltration	++
plants damaged by wind	NA
PLANTS MANAGEMENT	
establishment, growth and harvest	
better germination due to improved water application in the lower 1/3 of field from improved application and infiltration	++
nutrient management	
improved intake could reduce the amount of nutrients available for plant use	–
pests	NA
threatened and endangered species	NA
DOMESTIC ANIMAL HABITAT	
food	NA
cover and shelter	NA
quantity and quality of drinking water	
decreased sediment in the water	+
airborne sediment and smoke safety on-site	NA
DOMESTIC ANIMAL MANAGEMENT	
population/resource balance	NA
animal health	NA
WILDLIFE ANIMAL HABITAT	
food	NA
cover and shelter	NA
quantity and quality of drinking water	
decreased sediment and contaminates in water supplies	+
threatened and endangered species	
most species	NA
significantly less sediment, attached nutrients and chemicals to fisheries and spawning beds	+++
potential impacts from polyacrylamide chemical composition	--
WILDLIFE ANIMAL MANAGEMENT	
population/resource balance	NA
animal health	NA